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NASA TECH BRIEF

Goddard Space Flight Center

Variable-Beamwidth Antenna Without Moving Parts

The problem:

Variable-beamwidth antennas are used in search and tracking operations. In the wide-beamwidth mode, the antenna searches for the signal. Once the signal is acquired, the antenna is switched to the narrow-beamwidth mode for tracking. In conventional arrangements (see NASA Tech Briefs B74-10041 and B74-10257), beamwidth is varied mechanically. A set of servos moves the reflectors and subreflectors in relation to each other to obtain the necessary beamwidth. Although effective, the moving parts add extra weight to the system.

The solution:

A new monopulse antenna system incorporates two sets of feeds to vary the beamwidth. Because no moving parts are used, this system is lighter than the conventional ones. This makes it suitable for applications in which weight is a critical factor.

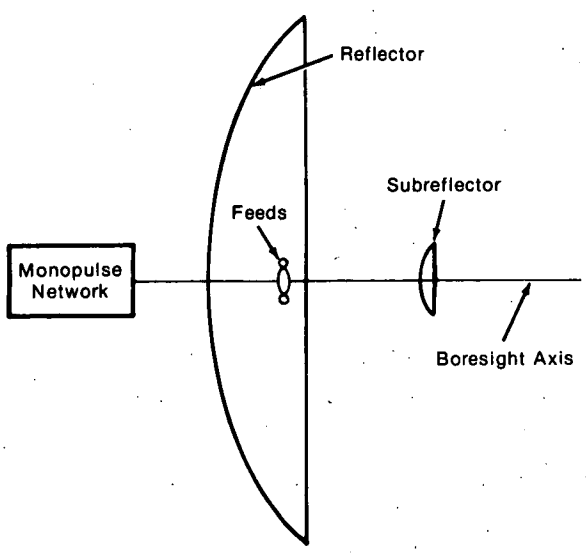

Figure 1. Antenna Configuration

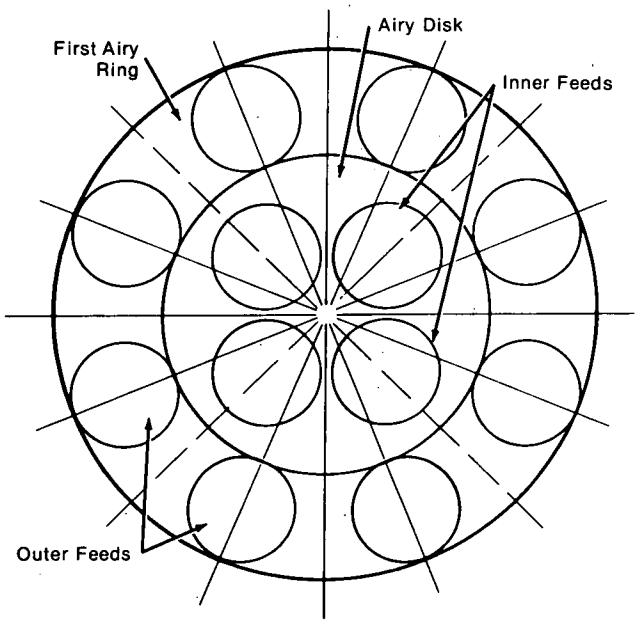

Figure 2. Two Sets of Feeds

How it's done:

The basic antenna configuration is shown in Figure 1. It consists of a large parabolic dish reflector, a smaller hyperboloidal subreflector, and two sets of monopulse feeds located in the conjugate focal region on the boresight axis of the dish.

The two sets of feeds are shown in a magnified drawing (Figure 2). The inner set, comprising four feed elements, is positioned within the effective region of the Airy disk at the conjugate focal plane of the subreflector. This subsystem, along with the large disk reflector, provides narrow-beamwidth monopulse, sum-and-difference channel radiation patterns that are suitable for tracking-mode operation. The second or outer set of monopulse feeds, located outside the Airy disk in the region of the first Airy ring, widens the beamwidth of the monopulse radiation pattern for acquisition-mode operation.

(continued overleaf)

When the antenna operates in the wide-beamwidth pattern (the acquisition mode), the difference channel is supplied by the outer set of feeds. The sum channel pattern is obtained by attenuating and phase shifting the sum channel pattern of the inner feeds. This then is added to the sum channel pattern of the outer feeds. The effect is that the sum channel pattern of the inner feeds is widened by the interferometer characteristics of the outer feeds. In the narrow-beamwidth mode (the tracking mode), the sum-and-difference channel radiation patterns are obtained from the inner set of feeds.

The entire operation is accomplished by independent control of the sum-and-difference channel patterns. This control is provided by the monopulse network consisting of a system of hybrid junctions. The network is connected to the feeds behind the antenna. Since the beamwidth is controlled purely by diode switching, there are no moving parts.

Note:

Requests for further information may be directed to:

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Patent status:

This invention is owned by NASA, and a patent application has been filed. Inquiries concerning nonexclusive or exclusive license for its commercial development should be addressed to:

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